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(FILE 'HOME' ENTERED AT 16:19:06 ON 10 AUG 2005)

FILE 'CAPLUS, USPATFULL' ENTERED AT 16:19:25 ON 10 AUG 2005

L1	61 S FUEL (W) CELL AND (LYASE OR CLOSTRIDI?)
L2	28 S FUEL (W) CELL AND (FORMATE (W) HYDROGEN (W) LYASE OR CLOSTRID
L3	1 S FUEL (W) CELL AND (FORMATE (W) HYDROGEN (W) LYASE AND CLOSTRI

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L2 ANSWER 1 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Bad date

Full Text	Citing References
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ACCESSION NUMBER: 2005:141224 CAPLUS  
DOCUMENT NUMBER: 142:238780  
TITLE: A composite layered biostructure containing a phototrophic genetically engineered Rhodopseudomonas palustris or other microbe for the production of hydrogen  
INVENTOR(S): Flickinger, Michael C.; Rey, Federico; Harwood, Caroline S.  
PATENT ASSIGNEE(S): Regents of the University of Minnesota, USA; University of Iowa Research Foundation  
SOURCE: PCT Int. Appl., 61 pp.  
CODEN: PIXXD2  
DOCUMENT TYPE: Patent  
LANGUAGE: English  
FAMILY ACC. NUM. COUNT: 1  
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
WO 2005014805	A1	20050217	WO 2004-US26257	20040809
W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW RW: BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				

PRIORITY APPLN. INFO.: US 2003-493745P P 20030808  
REFERENCE COUNT: 7 THERE ARE 7 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

IT Fuel cells  
(biochem. fuel cells; composite layered  
biostructure contg. phototrophic genetically engineered  
Rhodopseudomonas palustris or other microbe for hydrogen prodn.)

IT Algae  
Biological materials  
Carbon sources, microbial  
Chlamydomonas  
Clostridium butyricum  
Coating materials  
Coating process  
Composites  
Electric conductors  
Fermentation  
Genetic engineering  
Geobacter  
Immobilization, molecular or cellular  
Microorganism  
Optical absorption  
Rhodobacter  
Rhodococcus  
Rhodopseudomonas palustris  
Rubrivivax

## Transparent materials

(composite layered biostructure contg. phototrophic genetically engineered Rhodospseudomonas palustris or other microbe for hydrogen prodn.)

L2 ANSWER (2) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

*Bad date*

Full Text	Citing References
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ACCESSION NUMBER: 2004:667352 CAPLUS  
 DOCUMENT NUMBER: 141:409882  
 TITLE: Exploiting complex carbohydrates for microbial electricity generation - a bacterial fuel cell operating on starch  
 AUTHOR(S): Niessen, Juliane; Schroeder, Uwe; Scholz, Fritz  
 CORPORATE SOURCE: Institut fuer Chemie und Biochemie, Universitaet Greifswald, Greifswald, 17489, Germany  
 SOURCE: Electrochemistry Communications (2004), 6(9), 955-958  
 CODEN: ECCMF9; ISSN: 1388-2481  
 PUBLISHER: Elsevier B.V.  
 DOCUMENT TYPE: Journal  
 LANGUAGE: English  
 REFERENCE COUNT: 16 THERE ARE 16 CITED REFERENCES AVAILABLE FOR THIS

RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

- TI Exploiting complex carbohydrates for microbial electricity generation - a bacterial fuel cell operating on starch
- AB In this contribution we demonstrate that by combining specially designed anodes, consisting of platinum covered by poly(tetrafluoroaniline) and living cells of the biocatalyst *Clostridium butyricum* or *Clostridium beijerinckii* electricity can be generated from a variety of substrates, including starch, one of the major biomass constituents. Current densities between 1 and 1.3 mA cm<sup>-2</sup> are achieved by using glucose, molasses, or starch as fuel.
- ST bacterial fuel cell electricity generation
- IT Electric energy  
 (biochem.; exploiting complex carbohydrates for microbial electricity generation - bacterial fuel cell operating on starch)
- IT Anodes  
*Clostridium beijerinckii*  
*Clostridium butyricum*  
 Current density  
 Fermentation  
 Molasses  
 (exploiting complex carbohydrates for microbial electricity generation - bacterial fuel cell operating on starch)
- IT Immobilization, molecular or cellular  
 (microbial cell; exploiting complex carbohydrates for microbial electricity generation - bacterial fuel cell operating on starch)
- IT 50-21-5, Lactic acid, processes 50-99-7, D-Glucose, processes 9005-25-8, Starch, processes  
 RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process)  
 (exploiting complex carbohydrates for microbial electricity generation - bacterial fuel cell operating on starch)
- IT 163969-95-7  
 RL: BUJ (Biological use, unclassified); BIOL (Biological study); USES (Uses)  
 (exploiting complex carbohydrates for microbial electricity generation - bacterial fuel cell operating on starch)

L2 ANSWER (3) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 2002:714426 CAPLUS *End date*  
 DOCUMENT NUMBER: 137:250255  
 TITLE: Polymer electrolyte fuel cell set  
 INVENTOR(S): Yamamoto, Noriyuki; Yoneda, Tetsuya; Nishimura, Kazuhito; Komota, Mutsuko; Satomura, Masashi  
 PATENT ASSIGNEE(S): Sharp Corp., Japan  
 SOURCE: Jpn. Kokai Tokkyo Koho, 6 pp.  
 CODEN: JKXXAF  
 DOCUMENT TYPE: Patent  
 LANGUAGE: Japanese  
 FAMILY ACC. NUM. COUNT: 1  
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
JP 2002270210	A2	20020920	JP 2001-62411	20010306
PRIORITY APPLN. INFO.:			JP 2001-62411	20010306
TI	Polymer electrolyte fuel cell set			
AB	The fuel cell set has a fuel cell, having a polymer electrolyte membrane between a cathode and an anode, inside a container having a fuel inlet, a fuel cartridge contg. a chamber for an O contg. hydrocarbon fuel and a catalytic chamber contg. a biocatalyst producing H from the O contg. hydrocarbon, and a pipe, having 1 end connectable to the fuel inlet of the container and the other end insert-able in the fuel cartridge; where the other end penetrates both chambers in the cartridge and has ?1 open holes. The O contg. hydrocarbon is an alc., aldehyde, ketone, or carboxylic acid; and the biocatalyst is <i>clostridium butyricum</i> or formate dehydrogenase.			
ST	polymer electrolyte fuel cell biocatalytic hydrogen supply; alc biocatalytic hydrogen supply fuel cell; aldehyde biocatalytic hydrogen supply fuel cell; ketone biocatalytic hydrogen supply fuel cell; carboxylic acid biocatalytic hydrogen supply fuel cell; <i>clostridium butyricum</i> biocatalyst hydrogen supply fuel cell; formate dehydrogenase biocatalyst hydrogen supply fuel cell			
IT	<i>Clostridium butyricum</i> Fuel cells (polymer electrolyte fuel cells using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)			
IT	Alcohols, processes Aldehydes, processes Carboxylic acids, processes Ketones, processes RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process) (polymer electrolyte fuel cells using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)			
IT	<u>67-56-1</u> , Methanol, processes RL: BCP (Biochemical process); BIOL (Biological study); PROC (Process) (polymer electrolyte fuel cells using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)			
IT	<u>9028-85-7</u> , Formate dehydrogenase RL: CAT (Catalyst use); USES (Uses) (polymer electrolyte fuel cells using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)			
IT	<u>1333-74-0P</u> , Hydrogen, preparation RL: IMF (Industrial manufacture); PREP (Preparation) (polymer electrolyte fuel cells using biocatalytic cartridge for hydrogen supply from oxygen contg. org. compds)			

L2 ANSWER 4 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

INSTANT APP.

Full  
TextCiting  
References

ACCESSION NUMBER: 2002:696508 CAPLUS  
 DOCUMENT NUMBER: 137:204025  
 TITLE: Polymer electrolyte fuel cell  
 INVENTOR(S): Yamamoto, Noriyuki; Katoh, Nobuo; Yukawa, Hideaki  
 PATENT ASSIGNEE(S): Japan  
 SOURCE: U.S. Pat. Appl. Publ., 7 pp.  
 CODEN: USXXCO  
 DOCUMENT TYPE: Patent  
 LANGUAGE: English  
 FAMILY ACC. NUM. COUNT: 1  
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2002127440	A1	20020912	US 2002-87994	20020305
JP 2002270209	A2	20020920	JP 2001-62403	20010306
			JP 2001-62403	A 20010306

## PRIORITY APPLN. INFO.:

TI Polymer electrolyte fuel cell

AB A polymer electrolyte fuel cell includes a housing provided with an anode-side supply inlet for supplying a material for fuel, an anode and a cathode accommodated in the housing to sandwich a polymer electrolyte membrane, and a layer contg. a biochem. catalyst which decomp. the material for fuel to generate fuel, the layer being formed between the anode-side supply inlet and the anode.

ST fuel cell polymer electrolyte

IT Catalysts

(biochem.; polymer electrolyte fuel cell)

IT Polyoxyalkylenes, uses

RL: DEV (Device component use); USES (Uses)

(fluorine- and sulfo-contg., ionomers; polymer electrolyte fuel cell)

IT Anaerobic bacteria

Yeast

(hydrogen-generative; polymer electrolyte fuel cell)

IT Enzymes, uses

RL: CAT (Catalyst use); USES (Uses)

(hydrogen-generative; polymer electrolyte fuel cell)

IT Clostridium butyricum

(polymer electrolyte fuel cell)

IT Alcohols, uses

Aldehydes, uses

Carboxylic acids, uses

Ketones, uses

Polysaccharides, uses

RL: TEM (Technical or engineered material use); USES (Uses)

(polymer electrolyte fuel cell)

IT Fluoropolymers, uses

RL: DEV (Device component use); USES (Uses)

(polyoxyalkylene-, sulfo-contg., ionomers; polymer electrolyte fuel cell)

IT Ionomers

RL: DEV (Device component use); USES (Uses)

(polyoxyalkylenes, fluorine- and sulfo-contg.; polymer electrolyte fuel cell)

IT **Fuel cells**  
 (solid electrolyte; polymer electrolyte fuel cell)

IT 1333-74-0P, Hydrogen, uses  
 RL: BPN (Biosynthetic preparation); TEM (Technical or engineered material use); BIOL (Biological study); PREP (Preparation); USES (Uses)  
 (polymer electrolyte fuel cell)

IT 9028-85-7, Formate hydrogenlyase  
 RL: CAT (Catalyst use); USES (Uses)  
 (polymer electrolyte fuel cell)

IT 7440-06-4, Platinum, uses  
 RL: CAT (Catalyst use); DEV (Device component use); USES (Uses)  
 (polymer electrolyte fuel cell)

IT 7440-44-0, Carbon, uses  
 RL: DEV (Device component use); USES (Uses)  
 (polymer electrolyte fuel cell)

L2 ANSWER 5 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN ?

Full Text	Citing References
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ACCESSION NUMBER: 2002:487963 CAPLUS  
 DOCUMENT NUMBER: 137:67449  
 TITLE: Integrated anaerobic digester system  
 INVENTOR(S): Ainsworth, Jack L.; Atwood, Dan; Rideout, Tom  
 PATENT ASSIGNEE(S): USA  
 SOURCE: U.S. Pat. Appl. Publ., 20 pp., Cont.-in-part of U.S.  
 Ser. No. 602,684.  
 CODEN: USXXCO  
 DOCUMENT TYPE: Patent  
 LANGUAGE: English  
 FAMILY ACC. NUM. COUNT: 2  
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2002079266	A1	20020627	US 2001-963130	20010924
US 6569332	B2	20030527		
US 6299774	B1	20011009	US 2000-602684	20000626
CA 2461395	AA	20030522	CA 2001-2461395	20011130
WO 2003042117	A1	20030522	WO 2001-US45224	20011130
W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW				
RW: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				
EP 1446358	A1	20040818	EP 2001-987178	20011130
R: AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, SI, LT, LV, FI, RO, MK, CY, AL, TR				
PRIORITY APPLN. INFO.:				
			US 2000-602684	A2 20000626
			US 2001-963130	A 20010924
			WO 2001-US45224	W 20011130

IT **Actuators**  
 Aerators  
 Air conditioners  
 Bacillus (bacterium genus)  
 Clostridium

*Clostridium butyricum*  
*Clostridium propionicum*  
*Clostridium saccharoacetoperbutylicum*  
 Combustion engines  
 Compressors  
 Conveyors  
 Cooling apparatus  
 Electric motors  
*Escherichia*  
*Eubacteria*  
 Fuel cells  
 Furnaces  
 Heat exchangers  
 Manure  
*Methanobacterium*  
*Methanobacterium formicicum*  
*Methanobacterium omelianskii*  
*Methanobacterium propionicum*  
*Methanobacterium soehngenii*  
*Methanobacterium suboxydans*  
*Methanobrevibacter ruminantium*  
*Methanococcus vannielii*  
*Methanomicrobium mobile*  
*Methanomonas methanica*  
*Methanosarcina acetivorans*  
*Methanosarcina alcaliphilus*  
*Methanosarcina barkeri*  
*Methanosarcina mazei*  
*Methanosarcina thermophila*  
*Methanosarcina vacuolata*  
*Methanothermobacter thermautotrophicus*  
 Pressure sensors  
*Propionibacterium acidipropionici*  
 Pumps  
*Saccharomyces cerevisiae*  
*Saccharomyces ellipsoideus*  
*Sarcina methanica*  
*Staphylococcus*  
 Thermoregulators  
 Wastes  
 (integrated anaerobic digester system for converting cellulose-contg.  
 feedstock into useful materials)

L2 ANSWER 6 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 2002:102076 CAPLUS  
 DOCUMENT NUMBER: 136:382790  
 TITLE: A novel electrochemically active and Fe(III)-reducing  
 bacterium phylogenetically related to *Clostridium*  
*butyricum* isolated from a microbial fuel cell  
 AUTHOR(S): Park, Hyung Soo; Kim, Byung Hong; Kim, Hyo Suk; Kim,  
 Hyung Joo; Kim, Gwang Tae; Kim, Mia; Chang, In Seop;  
 Park, Yong Keun; Chang, Hyo Ihl  
 CORPORATE SOURCE: Water Environment Research Centre, Korea Institute of  
 Science and Technology, Hawolgok-dong, Sungpook-ku,  
 Seoul, 136-791, S. Korea  
 SOURCE: Anaerobe (2001), 7(6), 297-306  
 CODEN: ANAEF8; ISSN: 1075-9964  
 PUBLISHER: Academic Press

DOCUMENT TYPE: Journal  
 LANGUAGE: English  
 REFERENCE COUNT: 37 THERE ARE 37 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

- TI A novel electrochemically active and Fe(III)-reducing bacterium phylogenetically related to *Clostridium butyricum* isolated from a microbial fuel cell
- AB An obligatory anaerobic bacterium was isolated from a mediator-less microbial fuel cell using starch processing wastewater as the fuel and designated as EG3. The isolate was Gram-pos., motile and rod (2.8-3.0 µm long, 0.5-0.6 µm wide). The partial 16S rRNA gene sequence and anal. of the cellular fatty acids profile suggested that EG3 clusters with *Clostridium* sub-phyllum and exhibited the highest similarity (98%) with *Clostridium butyricum*. The temp. and pH optimum for growth were 37°C and 7.0, resp. The major products of glucose and glucose/Fe(O)OH metab. were lactate, formate, butyrate, acetate, CO<sub>2</sub> and H<sub>2</sub>. Growth was faster at the initial phase and the cell yield was higher when the medium was supplemented with Fe(O)OH than without Fe(O)OH. These results suggest that Fe(III) ion is utilized as an electron sink. Cyclic voltammetry showed that *Clostridium butyricum* EG3 cells were electrochem. active. It is a novel characteristic of strict anaerobic Gram-pos. bacteria. (c) 2001 Academic Press.
- IT *Clostridium butyricum*  
 Evolution  
 Growth, microbial  
 Metabolism, microbial  
 Ribotyping  
 Taxonomy  
 (novel electrochem. active and iron-reducing bacterium phylogenetically related to *Clostridium butyricum* isolated from microbial fuel cell)
- IT Fatty acids, biological studies  
 RL: BSU (Biological study, unclassified); BIOL (Biological study)  
 (novel electrochem. active and iron-reducing bacterium phylogenetically related to *Clostridium butyricum* isolated from microbial fuel cell)
- IT 7439-89-6, Iron, biological studies  
 RL: BSU (Biological study, unclassified); BIOL (Biological study)  
 (novel electrochem. active and iron-reducing bacterium phylogenetically related to *Clostridium butyricum* isolated from microbial fuel cell)

L2 ANSWER (7) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 2001:21517 CAPLUS  
 DOCUMENT NUMBER: 134:88628  
 TITLE: Apparatus for reforming hydrocarbon fuel gases to produce hydrogen  
 INVENTOR(S): Naito, Takeshi  
 PATENT ASSIGNEE(S): Nissan Motor Co., Ltd., Japan  
 SOURCE: Jpn. Kokai Tokkyo Koho, 6 pp.  
 CODEN: JKXXAF  
 DOCUMENT TYPE: Patent  
 LANGUAGE: Japanese  
 FAMILY ACC. NUM. COUNT: 1  
 PATENT INFORMATION:

check

bacteria in liquid.

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
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JP 2001003822      A2      20010109      JP 1999-173846      19990621  
 PRIORITY APPLN. INFO.:      JP 1999-173846      19990621  
 ST    reforming hydrocarbon gas hydrogen prodn **fuel cell**  
 IT    *Clostridium acetobutylicum*  
       *Clostridium butyricum*  
       *Clostridium lactoacetophilum*  
       **Fuel cells**  
       (app. for reforming hydrocarbon fuel gases to produce hydrogen by using  
       *Clostridium*-series bacteria)

L2    ANSWER 8 OF 28    CAPLUS    COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER:      1985:490301    CAPLUS  
 DOCUMENT NUMBER:      103:90301  
 TITLE:                    Manufacture of hydrogen using microorganisms  
 AUTHOR(S):                Wakao, Noriaki  
 CORPORATE SOURCE:        Coll. Eng., Yokohama Natl. Univ., Yokohama, Japan  
 SOURCE:                    Kemikaru Enjiniyaringu (1985), 30(6), 410-13  
                               CODEN: KEENAT; ISSN: 0387-1037  
 DOCUMENT TYPE:            Journal; General Review  
 LANGUAGE:                  Japanese  
 AB    A review, with 8 refs., on H generation from weed and tree leaves by  
       *Enterobacter aerogenes* 82005, and from alc. fermn. wastewater by  
       *Clostridium butyricum*. The use of the H for **fuel cell** is also discussed.  
 ST    hydrogen manuf microorganism review; biomass fermn hydrogen manuf review;  
       weed fermn hydrogen manuf review; *Enterobacter aerogenes* hydrogen manuf  
       review; *Clostridium butyricum* hydrogen manuf review; wastewater fermn  
       hydrogen manuf review; **fuel cell** hydrogen review  
 IT    **Fuel cells**  
       (hydrogen for)  
 IT    *Clostridium butyricum*  
       (hydrogen manuf. from alc.-fermn. wastewater by)

L2    ANSWER 9 OF 28    CAPLUS    COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER:      1984:441020    CAPLUS  
 DOCUMENT NUMBER:      101:41020  
 TITLE:                    Electrochemical conversion in biofuel cells using  
                               *Clostridium butyricum* or *Staphylococcus aureus* Oxford  
 AUTHOR(S):                Ardeleanu, Ioan; Margineanu, Doru Georg; Vais, Horia  
 CORPORATE SOURCE:        Membr. Biophys. Group, Inst. Biol. Sci., Bucharest,  
                               79651, Rom.  
 SOURCE:                    Bioelectrochemistry and Bioenergetics (1983), 11(4-6),  
                               273-7  
                               CODEN: BEBEBP; ISSN: 0302-4598  
 DOCUMENT TYPE:            Journal  
 LANGUAGE:                  English  
 TI    Electrochemical conversion in biofuel cells using *Clostridium*  
       *butyricum* or *Staphylococcus aureus* Oxford  
 ST    biochem **fuel cell** *Clostridium butyricum*; *Staphylococcus aureus*  
       biochem **fuel cell**; methylene blue biofuel cell; Hb biofuel cell  
 IT    **Fuel cells**  
       (bio-, using *Clostridium butyricum* or  
       *Staphylococcus aureus*)  
 IT    *Clostridium butyricum*  
       *Staphylococcus aureus*  
       (biofuel cells using)

onlyL2 ANSWER 10 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1984:409926 CAPLUS  
DOCUMENT NUMBER: 101:9926  
TITLE: Energy production with immobilized cells  
AUTHOR(S): Suzuki, Shuichi; Karube, Isao  
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
Yokohama, Japan  
SOURCE: Applied Biochemistry and Bioengineering (1983), 4,  
281-310  
CODEN: ABBID7; ISSN: 0147-0248  
DOCUMENT TYPE: Journal; General Review  
LANGUAGE: English

AB A review with 28 refs. Immobilization of H- and CH<sub>4</sub> [74-82-8]-producing microorganisms in synthetic or natural polymers is described, and gas prodn. with these immobilized cells is discussed. Subsequent application of the H to H-O fuel-cell system is also included. Immobilized bacteria, algae, and chloroplasts can be used for continuous prodn. of CH<sub>4</sub> or H, and can be used in a H-O fuel cell. Employment of immobilized microorganisms and organelles made possible prolonged gas prodn. However, the power obtained was weak. Improvement of H productivity is needed for practical use in a H-O fuel cell. Therefore, mol. breeding of H-producing bacteria is important for practical application of a bioenergy conversion system.

ST review immobilized cell energy; polymer immobilization hydrogen microorganism review; methane microorganism polymer immobilization review; fuel cell microbial review

IT Clostridium butyricum  
Cyanobacteria  
(fuel cells using immobilized)

IT Fuel cells  
(microbial, using immobilized Clostridium butyricum and blue-green algae)

IT 1333-74-0P, preparation  
RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)  
(manuf. of, by immobilized Clostridium butyricum and blue-green algae)

L2 ANSWER 11 OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1984:106578 CAPLUS  
DOCUMENT NUMBER: 100:106578  
TITLE: Biochemical energy conversion by immobilized whole cells  
AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsuoka, Hideaki; Ueyama, Satoshi; Kawakubo, Hiroaki; Isoda, Satoshi; Murahashi, Toshiaki  
CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
Yokohama, 227, Japan  
SOURCE: Annals of the New York Academy of Sciences (1983),  
413(Biochem. Eng. 3), 133-43  
CODEN: ANYAA9; ISSN: 0077-8923  
DOCUMENT TYPE: Journal  
LANGUAGE: English

AB H-producing bacteria, Clostridium butyricum, were immobilized in papers with agar (1.5%) gel. The immobilized whole cells (3 kg wet cells) were employed for continuous prodn. of H from molasses. The immobilized

whole cells continuously produced H<sub>2</sub> (400-800 mL/min) over a 2-mo period. H<sub>2</sub> produced was supplied to 2 H<sub>3</sub>PO<sub>4</sub> fuel cells connected in parallel. About 10-12 W and a current of 10-12 A were obtained for 10 h. The energy balance of the bacterial fuel-cell system is also discussed.

- ST fuel cell biochem; *Clostridium butyricum* hydrogen fuel cell; molasses *Clostridium butyricum* hydrogen manuf
- IT Fuel cells  
(bacterial, supplied with hydrogen produced continuously by immobilized whole cells of *Clostridium butyricum*, performance of)
- IT *Clostridium butyricum*  
(hydrogen manuf. from molasses by immobilized whole cells of, for fuel cells)
- IT Molasses  
(hydrogen manuf. from, by immobilized whole cells of *Clostridium butyricum*, for fuel cells)
- IT 1333-74-0P, preparation  
RL: PREP (Preparation)  
(manuf. of, from molasses by immobilized whole cells of *Clostridium butyricum*, for fuel cells)

L2 ANSWER (12) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

- | Full Text         | Citing References   |
|-------------------|---|
| ACCESSION NUMBER: | 1982:126193 CAPLUS  |
| DOCUMENT NUMBER:  | 96:126193   |
| TITLE:            | Photochemical fuel cell using immobilized chloroplast- <i>Clostridium butyricum</i>   |
| AUTHOR(S):        | Karube, I.; Suzuki, S.; Matsunaga, T.; Kayano, H.   |
| CORPORATE SOURCE: | Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, Japan  |
| SOURCE:           | Adv. Biotechnol., [Proc. Int. Ferment. Symp.], 6th (1981), Meeting Date 1980, Volume 3, 389-94.<br>Editor(s): Vezina, Claude; Singh, Kartar. Pergamon: Toronto, Ont.<br>CODEN: 47GQAB   |
| DOCUMENT TYPE:    | Conference  |
| LANGUAGE:         | English   |
| TI                | Photochemical fuel cell using immobilized chloroplast- <i>Clostridium butyricum</i>   |
| AB                | Spinach chloroplasts (Ch) and <i>Clostridium butyricum</i> (CB) were immobilized in 2% agar gel and used for light-induced H <sub>2</sub> evolution system. Crude ferredoxin (8 µM) isolated from spinach was used as an electron carrier. The optimum conditions for immobilized chloroplasts were pH 8.0 and 30°. The activity of chloroplasts under anaerobic and N <sub>2</sub> bubbling conditions was higher than that under aerobic conditions. H <sub>2</sub> produced was applied to a H <sub>2</sub> -O <sub>2</sub> fuel cell. The photochem. fuel cell system comprised immobilized Ch and CB reactors and fuel cell. A photocurrent of 0.4-1.5 mA was obtained for 4 h, the conversion ratio of H <sub>2</sub> to current being 80-100%. |
| ST                | <i>clostridium butyricum</i> hydrogen manuf; chloroplast hydrogen manuf; photochem fuel cell hydrogen oxygen; ferredoxin <i>clostridium butyricum</i> hydrogen manuf  |
| IT                | <i>Clostridium butyricum</i><br>(hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized chloroplast and, for fuel cells)   |
| IT                | Chloroplast<br>(hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized   |

**Clostridium butyricum** and, for fuel cells)

IT Ferredoxins

RL: USES (Uses)

(hydrogen manuf. from solns. contg., by agar gel-immobilized chloroplast and **Clostridium butyricum**, for fuel cells)

IT Fuel cells

(biochem., hydrogen-oxygen, hydrogen manuf. by agar gel-immobilized chloroplast-**Clostridium butyricum** for)

IT Energy

(solar, hydrogen manuf. from solns. contg. ferredoxin by agar gel-immobilized chloroplast-**Clostridium butyricum** and, for fuel cells)

IT 1333-74-0P, preparation

RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)

(manuf. of, by agar gel-immobilized chloroplast-**Clostridium butyricum** from solns. contg. ferredoxin, for fuel cells)

L2 ANSWER (13) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1982:71800 CAPLUS

DOCUMENT NUMBER: 96:71800

TITLE: Photochemical energy conversion system using immobilized chloroplasts

AUTHOR(S): Kayano, Hiromichi; Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuichi

CORPORATE SOURCE: Res. Lab. Resour. Utilization, Tokyo Inst. Technol., Yokohama, 227, Japan

SOURCE: Biotechnology and Bioengineering (1981), 23(10), 2283-91

CODEN: BIBIAU; ISSN: 0006-3592

DOCUMENT TYPE: Journal

LANGUAGE: English

AB Immobilized chloroplasts and **Clostridium butyricum** were employed for a photochem. energy conversion system. Spinach chloroplasts were immobilized in 2% agar gel. The optimum temp. of immobilized chloroplasts was 30?. The max. activity was obtained in a phosphate buffer soln. (pH 8.0) contg. 8  $\mu$ M ferredoxin under N bubbling condition. H was evolved under illumination by immobilized chloroplasts and C. butyricum. H produced by this system was applied to a H-O fuel cell. Photoinduced current was obtained from this photochem. energy conversion system. A photocurrent of 0.4-1.5 mA was continuously obtained for 4 h. The conversion ratio from H to current was 80-100%.

ST hydrogen manuf immobilized chloroplast; **Clostridium butyricum** immobilized hydrogen manuf; fuel cell biochem hydrogen oxygen

IT Chloroplast

**Clostridium butyricum**

(hydrogen manuf. by immobilized)

IT Fuel cells

(biochem., hydrogen-oxygen, performance of)

IT 1333-74-0P, preparation

RL: PREP (Preparation)

(manuf. of, by immobilized chloroplasts and **Clostridium butyricum**)

L2 ANSWER (14) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1981:553759 CAPLUS  
 DOCUMENT NUMBER: 95:153759  
 TITLE: Biochemical energy conversion by immobilized whole cells  
 AUTHOR(S): Karube, Isao; Suzuki, Shuichi; Matsunaga, Tadashi; Kuriyama, Shinichi  
 CORPORATE SOURCE: Res. Lab. Resources Util., Tokyo Inst. Technol., Yokohama, 227, Japan  
 SOURCE: Annals of the New York Academy of Sciences (1981), 369(Biochem. Eng. 2), 91-8  
 CODEN: ANYAA9; ISSN: 0077-8923  
 DOCUMENT TYPE: Journal  
 LANGUAGE: English  
 AB H-producing bacteria, *Clostridium butyricum*, were immobilized in 2% agar gel, and the whole cells were employed for continuous H prodn. from the wastewater of an alc. factory. H was produced with a batch system. The whole cells continuously produced 20 mL H/min-kg wet gel over 1-mo period. H produced was supplied to a unit of 5 in-series connected H-O (air) fuel cells having a max. voltage of -0.6 V/cell when H flow rate was 20 mL/min. The limiting c.d. changed from 0.4 to 40 mA/cm<sup>2</sup> as the resistance between the electrodes changed from 1 to 100  $\Omega$ . A current of 0.8 A and a total cell voltage of 2.2 V were obtained from the fuel-cell unit over a 10-day period.  
 ST *Clostridium butyricum* hydrogen manuf wastewater; fuel cell biochem hydrogen oxygen  
 IT *Clostridium butyricum*  
 (hydrogen manuf. by agar gel immobilized, from wastewater for fuel cells)  
 IT Wastewater  
 (winery, hydrogen manuf. by *Clostridium butyricum* from)  
 IT Fuel cells  
 (biochem., hydrogen-oxygen, hydrogen manuf. by immobilized *Clostridium butyricum* from wastewater for)  
 IT 1333-74-0P, preparation  
 RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP (Preparation)  
 (manuf. of, by agar gel immobilized *Clostridium butyricum* from wastewater for fuel cells)

L2 ANSWER (15) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1981:194921 CAPLUS  
 DOCUMENT NUMBER: 94:194921  
 TITLE: Biochemical energy conversion system  
 AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi; Kayano, Hiromichi  
 CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan  
 SOURCE: Enzyme Engineering (1980), 5, 143-5  
 CODEN: ENENDT; ISSN: 0094-8500  
 DOCUMENT TYPE: Journal  
 LANGUAGE: English  
 AB A biochem. fuel cell system using immobilized whole cells of *Clostridium butyricum* and a photochem. fuel cell using immobilized chloroplasts and *Clostridium butyricum* are described. The biochem. fuel cell was left on for 7 days, and a current of 500-50 mA was

continuously obtained. The photochem. fuel cell was operated under illumination and a photocurrent of 170  $\mu$ A was obtained for 2.5 h.

ST biochem fuel cell clostridium butyricum; photochem fuel cell clostridium butyricum; chloroplast photochem fuel cell

IT **Clostridium butyricum**  
(biochem. and photochem. fuel cells contg. immobilized)

IT Chloroplast  
(photochem. fuel cells contg. immobilized)

IT Ferredoxins  
RL: USES (Uses)  
(photochem. fuel cells contg. immobilized chloroplasts and)

IT **Fuel cells**  
(biochem., with immobilized whole cells of **Clostridium butyricum**)

IT Photoelectric devices  
(solar, biochem., with immobilized chloroplasts and **Clostridium butyricum**)

IT 330-54-1 13096-46-3  
RL: USES (Uses)  
(photochem. fuel cells contg. immobilized chloroplasts and)

L2 ANSWER (16) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1981:99214 CAPLUS

DOCUMENT NUMBER: 94:99214

TITLE: A specific microbial sensor for formic acid

AUTHOR(S): Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuich

CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Yokohama, 227, Japan

SOURCE: European Journal of Applied Microbiology and Biotechnology (1980), 10(3), 235-43  
CODEN: EJABDD; ISSN: 0171-1741

DOCUMENT TYPE: Journal

LANGUAGE: English

AB A microbial sensor consisting of immobilized **Clostridium butyricum**, 2 gas permeable Teflon membranes, and fuel cell type electrode was suitable for the detn. of formic acid. When the sensor was inserted into the sample soln. contg. formic acid, the current increases to a steady state with a response time of 20 min. The relation between the steady state current and the formic acid concn. is linear up to 1000 mg/L. The currents are reproducible with an av. relative error of 5%. Selectivity of the sensor is satisfactory. Results obtained with this sensor and by gas chromatog. were in good agreement when the cultivation medium of *Aeromonas formicans* was employed. Immobilized *C. butyricum* is stable for >20 days.

IT **Clostridium butyricum**  
(immobilized, on electrodes for formic acid detn.)

L2 ANSWER (17) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1981:43980 CAPLUS

DOCUMENT NUMBER: 94:43980

TITLE: Some observations on immobilized hydrogen-producing bacteria: behavior of hydrogen in gel membranes

AUTHOR(S): Matsunaga, Tadashi; Karube, Isao; Suzuki, Shuichi

CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
Yokohama, 227, Japan

SOURCE: Biotechnology and Bioengineering (1980), 22(12),  
2607-15  
CODEN: BIBIAU; ISSN: 0006-3592

DOCUMENT TYPE: Journal

LANGUAGE: English

AB An H<sub>2</sub>-forming bacterium, *Clostridium butyricum*, was immobilized in gel membranes that were exposed on 1 side to a glucose soln. as bacterial substrate, and the prodn. of H<sub>2</sub> on the other side of the gel membrane was studied. Polyacrylamide gel, overall, was superior to agar gel and collagen membranes when mech. rigidity, glucose diffusion rate, and protection of bacterial viability were compared. The bacteria-polyacrylamide gel membrane is applicable as a microbial sensor because of its good diffusional and mech. properties. However, a whole cell-entrapped membrane electrode is not suitable for a fuel cell, because most of the H<sub>2</sub> diffused to the substrate side, and not the electrode side, of the membrane.

ST immobilized *Clostridium* hydrogen; sensor polyacrylamide gel *Clostridium*; **fuel cell** *Clostridium* immobilized hydrogen

IT Membranes and Diaphragms  
(gel, hydrogen prodn. by *Clostridium butyricum* immobilized in)

IT *Clostridium butyricum*  
(hydrogen prodn. by, immobilized in gel membranes)

IT Electrodes  
(bio-, gel membrane-immobilized *Clostridium butyricum* as)

IT **Fuel cells**  
(biochem., gel membrane-immobilized *Clostridium butyricum* as hydrogen producer for)

L2 ANSWER (18) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1980:443917 CAPLUS

DOCUMENT NUMBER: 93:43917

TITLE: Biochemical energy conversion using immobilized whole cells of *Clostridium butyricum*

AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi; Kuriyama, Shinichi; Suzuki, Nobukazu; Shirogami, Tamotsu; Takamura, Tsutomu

CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
Yokohama, 227, Japan

SOURCE: Biochimie (1980), 62(5-6), 353-8  
CODEN: BICMBE; ISSN: 0300-9084

DOCUMENT TYPE: Journal

LANGUAGE: English

TI Biochemical energy conversion using immobilized whole cells of *Clostridium butyricum*

AB A H<sub>2</sub>-producing bacterium, *Clostridium butyricum*, was immobilized in 2% agar gel. The immobilized whole cells were employed for continuous prodn. of H<sub>2</sub> from alc. factory waste waters. The H<sub>2</sub> prodn. rate became const. at >BOD 1500 ppm when H<sub>2</sub> prodn. was performed with a batch system. The immobilized whole cells continuously produced H<sub>2</sub> over a 20-day period. The amt. of H<sub>2</sub> produced was ~6 mL/min/kg wet gels. H<sub>2</sub> produced was supplied to the H<sub>2</sub>-O<sub>2</sub> (air) fuel cells. The max. cell voltage of cell I and II was ~55 and 0.66 V, resp., when the flow rate of H<sub>2</sub> was 6 mL/min. The limiting c.d. changed from 0.4 to 40 mA/cm<sup>2</sup> as the resistance between the electrodes changed from 1 to 100 Ω. The **fuel cell**

was left on for 7 days and current of 550-500 mA was obtained continuously over a 7 day period.

ST hydrogen immobilized Clostridium; wastewater hydrogen fuel cell  
 IT Wastewater  
     (fermn. of, hydrogen prodn. by, with immobilized Clostridium  
     butyricum)  
 IT Fuel cells  
     (hydrogen prodn. for, with immobilized Clostridium  
     butyricum)  
 IT Clostridium butyricum  
     (immobilized, hydrogen prodn. from wastewater with)  
 IT 1333-74-0P, preparation  
     RL: BMF (Bioindustrial manufacture); BIOL (Biological study); PREP  
     (Preparation)  
     (manuf. of, for fuel cells, with immobilized  
     Clostridium butyricum)

L2 ANSWER (19) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

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Full Text	Citing References
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ACCESSION NUMBER: 1979:460174 CAPLUS  
 DOCUMENT NUMBER: 91:60174  
 TITLE: Application of a biochemical fuel cell to wastewaters  
 AUTHOR(S): Suzuki, Shuichi; Karube, Isao; Matsunaga, Tadashi  
 CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
     Yokohama, 227, Japan  
 SOURCE: Biotechnology and Bioengineering Symposium (1979),  
     8(Biotechnol. Energy Prod. Conserv.), 501-11  
     CODEN: BIBSBR; ISSN: 0572-6565  
 DOCUMENT TYPE: Journal  
 LANGUAGE: English  
 TI Application of a biochemical fuel cell to wastewaters  
 AB The performance of a biochem. fuel-cell system was evaluated. The  
     system used in the study consisted of a wastewater reservoir, packed-bed  
     reactor for immobilized Clostridium butyricum, Pt black anode,  
     ion-exchange membrane, C cathode, and continuously stirred tank reactor  
     for immobilized aerobic microorganisms. Industrial wastewaters were  
     applied to the system. H prodn. by immobilized whole cells and wastewater  
     treatment by immobilized microorganisms are discussed.  
 ST biochem fuel cell wastewater  
 IT Wastewater treatment  
     (biochem. fuel cells in)  
 IT Clostridium butyricum  
     (biochem. fuel cells with wastewater as nutrient  
     for immobilized cells of)  
 IT Fuel cells  
     (biochem., with wastewater as nutrient for immobilized cells of  
     Clostridium butyrium)

L2 ANSWER (20) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

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Full Text	Citing References
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ACCESSION NUMBER: 1978:76413 CAPLUS  
 DOCUMENT NUMBER: 88:76413  
 TITLE: Biochemical fuel cell utilizing immobilized cells  
     of Clostridium butyricum  
 AUTHOR(S): Karube, Isao; Matsunaga, Tadashi; Tsuru, Shinya;  
     Suzuki, Shuichi  
 CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol.,  
     Yokohama, Japan



SOURCE: Biotechnology and Bioengineering (1977), 19(11), 1727-33  
 CODEN: BIBIAU; ISSN: 0006-3592

DOCUMENT TYPE: Journal

LANGUAGE: English

TI Biochemical fuel cell utilizing immobilized cells of *Clostridium butyricum*

AB The anode reaction of a biochem. fuel cell which uses immobilized bacteria is described. A rolled Pt black anode and a C cathode were used. One side of the anode was covered with gel-entrapped microorganism (~0.1 cm thick). The anolyte was 250 mL of 0.1M phosphate buffer (pH 7.7) contg. 0.25M glucose. The catholyte was 100 mL of 0.1M phosphate buffer (pH 7.7). The temp. of the biochem. fuel-cell system was maintained at 37 ± 1°. From 1 mol glucose, 0.6 mol H and 0.2 mol HCO<sub>2</sub>H were produced by immobilized *Clostridium butyricum*. The current-potential relations of H and HCO<sub>2</sub>H are shown and discussed. A high-power biochem. fuel cell is possible by using bacteria which produce larger amts. of H or HCO<sub>2</sub>H than *Clostridium butyricum*.

ST biochem fuel cell; *clostridium butyricum* fuel cell

IT *Clostridium butyricum*  
 (fuel cells with immobilized, biochem., anode reaction of)

IT Fuel cells  
 (biochem., with immobilized *Clostridium butyricum*)

IT 7440-06-4, uses and miscellaneous  
 RL: USES (Uses)  
 (anodes, covered with gel-entrapped *Clostridium butyricum*, biochem. fuel-cell, reaction of)

L2 ANSWER (2) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1977:158235 CAPLUS

DOCUMENT NUMBER: 86:158235

TITLE: Conversion of natural products by biofuel cells

AUTHOR(S): Silverman, H. P.

CORPORATE SOURCE: Sci. Appl. Inc., La Jolla, CA, USA

SOURCE: AICHE Symposium Series (1976), 72(158), 49-51  
 CODEN: ACSSCQ; ISSN: 0065-8812

DOCUMENT TYPE: Journal; General Review

LANGUAGE: English

AB The use of glucose oxidn. urea conversion to NH<sub>3</sub>, and generation of HCO<sub>2</sub>H [64-18-6] by the action of *Pseudomonas formicans* on a carbohydrate source with subsequent electrochem. oxidn. of the HCO<sub>2</sub>H to CO<sub>2</sub> in a fuel cell is reviewed. 10 Refs.

IT *Aeromonas hydrophila formicans*  
 (formic acid formation by, from carbohydrates, biochem. fuel cell in relation to)

IT *Clostridium butyricum*  
 (hydrogen prepn. by, from glucose, biochem. fuel cell in relation to)

IT *Bacillus pasteurii*  
 (urea decompn. to ammonia by, biochem. fuel cell in relation to)

IT Fuel cells  
 (biochem.)

IT 57-13-6, reactions  
 RL: RCT (Reactant); RACT (Reactant or reagent)  
 (decompn. of, biochem. fuel cell in relation to)

IT 50-99-7, reactions 64-18-6, reactions  
 RL: RCT (Reactant); RACT (Reactant or reagent)

(oxidn. of, biochem. fuel cell in relation to)

L2 ANSWER (22) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1973:157771 CAPLUS  
 DOCUMENT NUMBER: 78:157771  
 TITLE: Biochemical battery  
 AUTHOR(S): Suzuki, Shuichi  
 CORPORATE SOURCE: Res. Lab. Resour. Util., Tokyo Inst. Technol., Tokyo, Japan  
 SOURCE: Farumashia (1972), 8(2), 89-93  
 CODEN: FARUAW; ISSN: 0014-8601  
 DOCUMENT TYPE: Journal; General Review  
 LANGUAGE: Japanese

AB An electrode reaction composed of an electron transfer system in a biol. oxidn.-redn. reaction was explained with examples such as quinone-hydroquinone with oxidase, cystine-cysteine with Fe ion and glucose with ferricyanide or NADP. Electron transfer to the anode in cultures of *Clostridium butyricum* with glucose was an example of the use of microbial culture systems. Medical application of biol. fuel cells was suggested.

IT Fuel cells  
 (biol.)

L2 ANSWER (23) OF 28 CAPLUS COPYRIGHT 2005 ACS on STN

Full Text	Citing References
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ACCESSION NUMBER: 1967:420597 CAPLUS  
 DOCUMENT NUMBER: 67:20597  
 TITLE: Biochemical fuel cells  
 AUTHOR(S): Brake, Jon M.  
 CORPORATE SOURCE: Magna Corp., Anaheim, CA, USA  
 SOURCE: NASA (Nat. Aeronaut. Space Admin.) Access. (1965), AD 619665, 190 pp.  
 From: Sci. Tech. Aerospace Rept. 1965, 3(22), N65-34166  
 CODEN: NAACAF  
 DOCUMENT TYPE: Report  
 LANGUAGE: English

TI Biochemical fuel cells

AB A summary of the first years of an investigation into biochem. fuel cells is presented. The systems investigated included the H producers, *Clostridium butyricum* and *Escherichia coli*, the NH<sub>3</sub> producers, *Bacillus pasteurii*, urease, and L-amino acid oxidase, and the formic acid producers *Aeromonas formicans* and *E. coli*. The effects of temp., pH, ionic strength, and substrate on the rate of production of these fuels are reported. Electrochem. studies of the fuels were made under conditions compatible with their production. Formic acid proved to be the best choice. Current densities up to about 40 ma./cm.<sup>2</sup> were obtained with this fuel. Formic acid was produced in practical quantities from sugar, coconut juice, fruit juices, and exts. of yams. A biochem. battery operating on coconut juice was used to operate a transistor radio intermittently over 45 days for a total of 50 hrs. The coulombic efficiency of the cell approached 100% of the formic acid produced.

ST ELEC BIOCHEM FUELS; FUEL CELLS BIOCHEM; MICROBIAL FUEL CELLS; BATTERIES BIOCHEM

IT Fuel cells  
 (biochem.)

L2 ANSWER 24 OF 28 USPATFULL on STN

lyase

Bad date

Full Text	Citing References
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ACCESSION NUMBER: 2005:92806 USPATFULL  
 TITLE: Method for redesign of microbial production systems  
 INVENTOR(S): Maranas, Costas D., Port Matilda, PA, UNITED STATES  
 Burgard, Anthony P., State College, PA, UNITED STATES  
 Pharkya, Priti, State College, PA, UNITED STATES  
 PATENT ASSIGNEE(S): The Penn State Research Foundation, University Park,  
 PA, UNITED STATES (U.S. corporation)

	NUMBER	KIND	DATE
PATENT INFORMATION:	US 2005079482	A1	20050414
APPLICATION INFO.:	US 2004-929091	A1	20040826 (10)
RELATED APPLN. INFO.:	Continuation-in-part of Ser. No. US 2003-616659, filed on 9 Jul 2003, PENDING		

	NUMBER	DATE
PRIORITY INFORMATION:	US 2002-395763P	20020710 (60)
	US 2002-417511P	20021009 (60)
	US 2003-444933P	20030203 (60)

DOCUMENT TYPE: Utility  
 FILE SEGMENT: APPLICATION  
 LEGAL REPRESENTATIVE: MCKEE, VOORHEES & SEASE, P.L.C., ATTN: PENNSYLVANIA  
 STATE UNIVERSITY, 801 GRAND AVENUE, SUITE 3200, DES  
 MOINES, IA, 50309-2721, US

NUMBER OF CLAIMS: 18  
 EXEMPLARY CLAIM: 1  
 NUMBER OF DRAWINGS: 6 Drawing Page(s)  
 LINE COUNT: 1594

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . and deletions, of microbial networks for the overproduction of  
 targeted compounds. These compounds may range from electrons or hydrogen  
 in bio-fuel cell and environmental applications to complex drug  
 precursor molecules. A comprehensive database of biotransformations,  
 referred to as the Universal database (with. . . .

DETD . . . Whited, 2003; Causey et al., 2004) or complex molecules such  
 as carotenoids (Misawa et al., 1991), to electrons in bio fuel cells  
 (Liu et al., 2004) or batteries (Bond et al., 2002; Bond et al., 2003)  
 to even microbes capable of precipitating. . . .

DETD . . . (see point A, in FIG. 3) leading to a growth-coupled  
 production mode. Note that hydrogen production takes place through the  
**formate hydrogen lyase** reaction which converts formate into  
 hydrogen and carbon dioxide under anaerobic conditions, in agreement  
 with current experimental observations (Nandi & . . . .

DETD . . . pyruvate which is then converted into formate through pyruvate  
 formate lyase. Formate is catabolized into hydrogen and carbon dioxide  
 through **formate hydrogen lyase**.

DETD . . . the lack of oxygen was preferred for hydrogen formation.  
 Notably, it has been reported (Nandi & Sengupta, 1996) that although  
**formate hydrogen lyase** can only be induced in the absence of  
 oxygen, it can function in aerobic environments. This will have to be.

L2 ANSWER 25 OF 28 USPATFULL on STN

Full Text	Citing References
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ACCESSION NUMBER: 2004:307100 USPATFULL

TITLE: Electrode compositions and configurations for  
electrochemical bioreactor systems

INVENTOR(S): Zeikus, Joseph Gregory, Okemos, MI, UNITED STATES  
Park, Doo Hyun, Seoul, KOREA, REPUBLIC OF

	NUMBER	KIND	DATE
PATENT INFORMATION:	US 2004241771	A1	20041202
APPLICATION INFO.:	US 2003-477273	A1	20031112 (10)
	WO 2002-US17143		20020531

	NUMBER	DATE
PRIORITY INFORMATION:	US 2001-294943P	20010531 (60)
	US 2001-338245P	20011108 (60)
	US 2002-353037P	20020130 (60)

DOCUMENT TYPE: Utility

FILE SEGMENT: APPLICATION

LEGAL REPRESENTATIVE: MCLEOD & MOYNE, P.C., 2190 COMMONS PARKWAY, OKEMOS, MI,  
48864

NUMBER OF CLAIMS: 46

EXEMPLARY CLAIM: 1

NUMBER OF DRAWINGS: 13 Drawing Page(s)

LINE COUNT: 1577

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . R. Norris and D. W. Ribbons (eds.). Methods in Microbiology. Academic Press, New York, 1992; Bennetto, et al. "The Sucrose Fuel Cell: Efficient Biomass Conversion Using A Microbial Catalyst", Biotechnol. Lett. 7:699-105, 1985; Roller et al., "Electron-Transfer Coupling In Microbial Fuel Cells: 1. Comparison Of Redox-Mediator Reduction Rates And Respiratory Rates Of Bacteria", J. Chem. Tech. Biotechnol. 34B:3-12, 1984; and Thurston, et al., "Glucose Metabolism In A Microbial Fuel Cell. Stoichiometry Of Product Formation In A Thionine-Mediated Proteus Vulgaris Fuel Cell And Its Relation To Coulombic Yields". J. Gen. Microbial. 131:1393-1401,1985.). Chemical energy is converted to electric energy by coupling the . . . 247-283, In J. R. Norris and D. W. Ribbons (eds.). Methods in Microbiology. Academic Press, New York, 1992). In microbial fuel cells, two redox couples are required, one for coupling reduction of an electron mediator to bacterial oxidative metabolism, and the other. . . surface where the electron acceptor is regenerated with atmospheric oxygen (see, Ardeleanu, et al., "Electrochemical Conversion In Biofuel Cells Using Clostridium Butyricum Or Staphylococcus Aureus Oxford", Bioelectrochem. Bioenerg, 11:273-277, 1983; and Delaney, et al., "Electron-Transfer Coupling In Microbial Fuel Cells. 2. Performance Of Fuel Cells Containing Selected Microorganism-Mediator-Substrate Combinations", Chem. Tech. Biotechnol. 34b:13-27,1985).

SUMM . . . mediators such as 2-hydroxy-1,4-naphtoquinone (HNQ) or thionin (see, Tanaka et al., "Effects Of Light On The Electrical Output Of Bioelectrochemical Fuel-Cells Containing Anabaena Variabilis M-2: Mechanisms Of The Post Illumination Burst", Chem. Tech. Biotechnol. 42:235-240,1988; and Tanaka et al., "Bioelectrochemical Fuel-Cells Operated By The Cyanobacterium, Anabaena Variabilis", Chem. Tech. Biotechnol. 35B: 191-197, 1985). Park et al. in "Electrode Reaction Of Desulfovibrio. . . 1812:2403-2410, 1999), or converting microbial reducing power into electricity in biofuel cells (see, Park and Zeikus, "Electricity Generation In Microbial Fuel Cells Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66:1292-1297, 2000). Park et al. in "Electricity Production In Biofuel Cell. . . Biotech. Lett. 22:1301-1304, 2000 showed that binding neutral red to a graphite

electrode further enhanced electron transfer efficiency in microbial fuel cells.

SUMM . . . Electron Donor For Growth And Metabolite Production", Appl. Environ. Microbiol. pp. 2912-2917, 1990; Park and Zeikus, "Electricity Generation In Microbial Fuel Cells Using Neutral Red As An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000; and U.S. Pat. No. 6,270,649).

SUMM . . . bacterial cultures. In one specific application, there is a need for an improved electrode that has utility as an enzymatic fuel cell, as a sensor for succinate detection, and as an engineered catalyst for the synthesis of fumarate or succinate. In particular, . . .

SUMM . . . contains bacterial cells, electron mediator, and reduced substrate (see, for example, Ardeleanu, et al., "Electrochemical Conversion In Biofuel Cells Using *Clostridium Butyricum* Or *Staphylococcus Aureus* Oxford", Bioelectrochem. Bioenerg, 11:273-277, 1983; and Park and Zeikus, "Electricity Generation In Microbial Fuel Cells Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66:1292-1297, 2000). Two compartment fuel cells are generally not practical because of the requirement for a ferricyanide solution and aeration in the cathode compartment. Thus, there. . .

SUMM . . . of the present invention to provide an electrochemical bioreactor system having an improved electrode that has utility as an enzymatic fuel cell.

SUMM [0025] It is yet another advantage of the invention to provide a fuel cell system that can be used as either an enrichment device for electrophilic microorganisms; that is, those which use an electrode. . .

DRWD [0029] FIG. 3 is a schematic diagram of a single compartment fuel cell according to a third aspect of the invention depicting electron transfer from cell metabolism to the anode metals to the. . .

DRWD [0030] FIG. 4 is a diagrammatic representation of the single compartment fuel cell of FIG. 3. The single compartment fuel cell comprises a Pyrex.TM. glass container (total volume 500 ml.) with a Fe<sup>3+</sup> cathode (50 cm<sup>2</sup> surface area) and a rubber. . .

DRWD . . . 5 is a comparison of electrical current and potential levels obtained when *Escherichia coli* was used in a two compartment fuel cell (A, B and C) versus a single compartment fuel cell (D, E and F). Three different types of anode and cathode combinations were applied to each fuel cell system. (A) and (D) were a woven graphite anode and a, Fe<sup>3+</sup> graphite cathode; (B) and (E) were a neutral. . .

DRWD . . . 6 is a comparison of electrical current and potential levels obtained when sewage sludge was used in a two compartment fuel cell (A, B and C) versus a single compartment fuel cell (D, E and F). Three different types of anode and cathode combinations were applied to each fuel cell system. (A) and (D) were a woven graphite anode and a Fe<sup>3+</sup> graphite cathode; (B) and (E) were a woven. . .

DETD . . . shown a schematic that depicts how the CMC-NR-NAD<sup>+</sup>-fumarate reductase enzyme immobilized onto the graphite felt electrode can function as a fuel cell during succinate oxidation and as a catalyst producing succinate from electricity and fumarate. The oxidation of succinate to fumarate coupled. . .

DETD . . . also dependent on current and fumarate concentration. This electrochemical bioreactor system can enhance the utility of oxidoreductases in diverse enzymatic fuel cells, chemical synthesis and chemical detection.

DETD . . . electrochemical bioreactor system is shown in FIGS. 3 and 4. FIG. 3 provides a schematic of how the single compartment fuel cell works. Bacteria attach to the anode and electrons are transferred from the cells metabolic pool to reduce either neutral red. . .

- DETD [0063] The cathodes differed from the anodes in the single compartment **fuel cell** because the inside of the cathode was coated with a 1 millimeter thickness porcelain septum made from 100% kaolin. The. . .
- DETD **Fuel Cell Design And Operation**
- DETD [0064] Two compartment cell **fuel cells** were prepared using the configuration described in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000, except for using the electrodes prepared in Example 2;. . . mm by 2 mm thick porcelain septum made from 100% Kaolin as described above in Example 2. The two compartment **fuel cell** of Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000 requires aeration and ferricyanide solution in the cathode compartment.
- DETD [0065] Because two compartment **fuel cells** are generally not practical because of the requirement for a ferricyanide solution and aeration in the cathode compartment, single compartment **fuel cell** design as shown in FIGS. 3 and 4 was prepared in order to eliminate the requirements for a ferricyanide solution and aeration in the cathode compartment. FIG. 3 provides a schematic of how the single compartment **fuel cell** works. Bacteria attach to the anode and electrons are transferred from the cells metabolic pool to reduce either neutral red. . . sewage sludge using soluble neutral red and a plain, woven graphite electrode (See, Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000).
- DETD . . . Resting cell suspensions in anolyte medium I were placed in the anoxic anode compartment of the two versus one compartment **fuel cell** systems and electrical current and potential were measured as reported in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000. Experiments compared electrical performance of E. coli versus sewage sludge in two versus one compartment **fuel cells** that contained different electrode compartments for the anode and cathode. The electrical measurements used a joule as the unit of. . . system per time unit. For calculations of the joule value, the current, potential and time were all measured in the **fuel cells** employed.
- DETD Single Compartment **Fuel Cell**--Electricity Production By E. Coli
- DETD [0067] FIG. 5 compares electricity generation by E. coli in a two compartment **fuel cell** as prepared as described above (A, B and C) versus a single compartment **fuel cell** as prepared as described above (D, E, and F) with different electrode compositions. Potential was higher in the two compartment **fuel cell**; whereas current wasp equivalent in either **fuel cell** system. Current was significantly lower when a woven graphite anode and a Fe<sup>3+</sup> graphite cathode were used. Notably, nearly equivalent. . . obtained when either a neutral red woven graphite anode or a Mn<sup>4+</sup> graphite anode were used as electrodes in either **fuel cell** system with a Fe<sup>3+</sup> graphite cathode.
- DETD . . . using the neutral red-woven graphite electrode developed here versus the system described in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000 using soluble neutral red and a woven graphite as. . .
- DETD . . . by sewage sludge microbes in a two compartment fuel call as prepared above (A, B, C) versus a one compartment **fuel cell** as prepared above (D, E, F). Current was higher in the single compartment **fuel cell** than the two compartment **fuel cell** with all anode-cathode combinations tested; whereas, the potential was nearly equivalent. Sewage sludge bacteria produced significantly higher current levels than. . .

DETD [0070] After the experiments were finished, the anode was removed from the one compartment **fuel cell** and examined it by scanning electron microscopy (see FIG. 7). Sample preparation and scanning electron microscopy investigation were performed at. . . for Advanced Microscopy, East Lansing, Mich., USA. The graphite felt was removed at the end of the experiment in the **fuel cell** containing sewage sludge and glucose. The graphite felt electrode sample (cut from electrode surface 55x51 mm) was fixed in 4% . . .

DETD [0071] Practical improvements have been demonstrated in both microbial **fuel cell** designs and enhanced microbial electron transfer efficiencies with new cathode and anode compositions. The new single compartment **fuel cell** system offers advantages over a conventional two compartment **fuel cell**. First, the new single compartment **fuel cell** system is simpler and less expensive to construct and operate, Second, the single compartment **fuel cell** system eliminates the need for a ferricyanide catholyte and aeration which might use more energy than the **fuel cell** makes, Third; the single compartment **fuel cell** system replaces the expensive proton selective membrane with a porcelain septum. Fourth, the use of a Fe+3 graphite cathode enhances. . .

DETD . . . the different potential and current levels obtained when different anode and cathode configurations were used to produce electricity in microbial **fuel cells** using either E. coli or anaerobic sewage sludge. In general, the over-all electron driving force is directly related to the. . .

DETD [0073] Previously, soluble electron mediators were used in **fuel cells** such as neutral red, thionin, and 2-hydroxyl-1,4-naphtoquinone to convert microbial reducing power into electricity. Most soluble electron donors except for. . . as well or better than a neutral: red woven graphite in coupling electron transfer from microbes to electricity production in **fuel cells**. In sum, these two new anode compositions significantly enhanced electron transfer efficiencies in microbial **fuel cells** from that reported previously.

DETD [0074] Resting cells in the new **fuel cell** system described here were using lactate as the electron donor and the anode as the electron acceptor for energy metabolism.. . .

DETD . . . cathode) as the electron donor while reducing CO<sub>2</sub> as the electron acceptor (see, Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol., 66:1292-1297, 2000). Kim et al. in "Direct Electrode Reaction Of Fe(III)-Reducing. . .

DETD . . . intending to be bound by theory, it is believed that the Mn<sup>4+</sup> graphite and the neutral red-woven graphite electrodes and **fuel cells** described herein may prove useful as "lightning rods" for the enrichment of electrophiles.

DETD . . . 0.2204  
with electricity

ainitial fumarate concentration used was 60 mM .

bwhich were extracted as in Park and Zeikus, "Electricity Generation In Microbial **Fuel Cells** Using Neutral Red And An Electronophore", Appl. Environ. Microbiol. 66: 1292-1297, 2000.

Resting cells were obtained from 16 hour cultivated. . .

DETD . . . rate of electron transfer from cells. The electrochemical bioreactor system has an improved electrode that has utility as an enzymatic **fuel cell**, as a sensor for succinate detection, and as an engineered catalyst for the synthesis of fumarate or succinate. The electrochemical. . .

L2 ANSWER 26 OF 28 USPATFULL on STN*INSTANT APP.*

Full Text	Citing References
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ACCESSION NUMBER: 2002:235255 USPATFULL  
 TITLE: Polymer electrolyte **fuel cell**  
 INVENTOR(S): Yamamoto, Noriyuki, Kashiba-shi, JAPAN  
 Kato, Nobuo, Kameoka-shi, JAPAN  
 Yukawa, Hideaki, Kyoto-shi, JAPAN

	NUMBER	KIND	DATE
PATENT INFORMATION:	<u>US 2002127440</u>	A1	20020912
APPLICATION INFO.:	<u>US 2002-87994</u>	A1	20020305 (10)

	NUMBER	DATE
PRIORITY INFORMATION:	<u>JP 2001-62403</u>	20010306
DOCUMENT TYPE:	Utility	
FILE SEGMENT:	APPLICATION	
LEGAL REPRESENTATIVE:	NIXON & VANDERHYE P.C., 8th Floor, 1100 North Glebe Road, Arlington, VA, 22201	
NUMBER OF CLAIMS:	7	
EXEMPLARY CLAIM:	1	
NUMBER OF DRAWINGS:	1 Drawing Page(s)	
LINE COUNT:	447	

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

TI Polymer electrolyte **fuel cell**

AB A polymer electrolyte **fuel cell** includes a housing provided with an anode-side supply inlet for supplying a material for fuel, an anode and a cathode.

SUMM [0003] The present invention relates to a polymer electrolyte **fuel cell**. More particularly, in the polymer electrolyte **fuel cell**, an oxygen-containing hydrocarbon is introduced as a material for fuel from a supply section for supplying the material for fuel, . . . a biochemical catalyst to generate hydrogen as fuel before the material for fuel reaches an anode of the polymer electrolyte **fuel cell**, and the generated hydrogen is supplied to the anode.

SUMM [0005] A **fuel cell** is provided with a cathode and an anode on both sides of an electrolyte. The cathode (oxidizer electrode) is supplied.

SUMM [0006] **Fuel cells** are classified into a number of groups such as alkaline **fuel cells**, acid **fuel cells**, molten carbonate **fuel cells**, solid oxide **fuel cells** and polymer electrolyte **fuel cells** (PEFCs) according to their types of electrolytes. Of these **fuel cells**, the PEFCs have proton-conductive solid polymers as electrolytes and are systems using high-purity hydrogen gas as fuel.

SUMM [0009] On the other hand, direct methanol-air **fuel cells** (DMFCs) are directly supplied with methanol as fuel. Since they can use proton-conductive polymers as electrolytes, the DMFCs can possibly.

SUMM [0010] Direct methanol-air **fuel cells** using proton-conductive polymer membranes as electrolytes (PEM-DMFCs) have a structure in which porous electrodes carrying electrocatalysts are formed on both.

SUMM . . . produced by such bacteria, an example is reported in which the produced hydrogen is supplied to the anode of a **fuel cell** and the amount of generated electricity is measured. However, this is not put into practical use as a polymer electrolyte **fuel cell** (Japanese Unexamined Patent Publication No. HEI 7(1995)-218469).

SUMM [0017] Accordingly, there is a demand for a polymer electrolyte **fuel cell** which uses an oxygen-containing hydrocarbon such as methanol as a



material for fuel and can generate electricity at low temperatures.

- SUMM [0018] An object of the present invention is to provide a polymer electrolyte fuel cell wherein a supplied oxygen-containing hydrocarbon is passed through a layer containing a biochemical catalyst comprised of a hydrogen-generative anaerobic bacterium, . . . the oxygen-containing hydrocarbon is decomposed to produce hydrogen, which is supplied as fuel to the anode of the polymer electrolyte fuel cell.
- SUMM [0019] The present invention provides a polymer electrolyte fuel cell comprising a housing provided with an anode-side supply inlet for supplying a material for fuel; an anode and a cathode. . . .
- SUMM [0020] Further the present invention provides a polymer electrolyte fuel cell comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel, the anode-side supply inlet being. . . .
- DRWD [0022] Fig. 1 is a schematic sectional view of a polymer electrolyte fuel cell whose anode-side collector is also used as a biochemical catalyst layer in accordance with the present invention; and
- DRWD [0023] FIG. 2 is a schematic sectional view of a polymer electrolyte fuel cell provided with a filter containing a biochemical catalyst layer for decomposing a hydrocarbon within a fuel supply path before the. . . .
- DETD [0024] The housing for accommodating the polymer electrolyte fuel cell usable in the present invention may be one formed of an electrically insulative resin such as acrylic resin, polypropylene resin, . . . .
- DETD . . . . for supplying the material for fuel includes all members used for supplying the material for fuel to the polymer electrolyte fuel cell. For example, the supply section includes a pipe for connecting the supply inlet to a generator which generates the material. . . . where the supply section is formed integrally with the housing, the supply section is a part of the polymer electrolyte fuel cell, and the polymer electrolyte fuel cell as a whole becomes smaller in size and simpler in shape. On the other hand, in the case where the. . . . inlet of the housing, the supply section is attached to the housing via the supply inlet when the polymer electrolyte fuel cell is used, and the supply section can be detached when the supply section is not required. Therefore, it is also possible to reduce the size of the polymer electrolyte fuel cell. An inlet for supply an oxidizer may also be provided on a cathode side of the housing.
- DETD . . . . for fuel is one or more species selected from the group consisting of hydrogen-generative anaerobic bacteria such as Clostridia (e.g., *clostridium butyricum*, *clostridium acetobutylicum*), Lactobacilli (e.g., *Lactobacillus pentoseifus*), and photosynthetic bacteria including Rhodospirilli (e.g., *Rhodospirillum rubrum*) and Rhodopseudomonas (e.g., *Rhodopseudomonas spheroides*); hydrogen-generative yeasts such as methylotrophic yeast; and hydrogen-generative enzymes such as methanol-assimilating enzyme, methanol dehydrase and formate-hydrogen lyase. Among these biochemical catalysts, a combination of *clostridium butyricum* and formate-hydrogen lyase is preferred.
- DETD [0030] In the present invention, the layer containing the biochemical catalyst may be located within the fuel cell, i.e., between the anode and the supply inlet on the anode side for supplying the material for fuel, or may. . . . for fuel. More particularly, in the case where the layer exists between the anode and the supply inlet within the fuel cell, the layer may be in the form of a filter in the supply inlet, or may also serve as an anode-side collector of the fuel cell. In the case where the layer exists within the supply section, the layer may be in the form of a. . . . the layer in the supply

section which is formed integrally with or separately from the housing of the polymer electrolyte **fuel cell**.

DETD . . . For example, if the biochemical catalyst is a combination of a hydrogen-generative anaerobic bacterium belonging to the genus *Clostridium* and **formate-hydrogen lyase**, the material for fuel is preferably methanol.

DETD . . . formic acid, which is formate-ionized. The generated formate ions produce hydrogen and carbon dioxide gas due to the action of **formate-hydrogen lyase**. ##STR1##

DETD [0035] The produced hydrogen is then supplied to the anode of the polymer electrolyte **fuel cell**, where hydrogen is oxidized to produce protons and electrons. The resulting protons migrate through the electrolyte toward cathode. On the . . . through an external circuit, producing an electric current. The produced carbon dioxide gas is discharged to the outside of the **fuel cell** system together with excess fuel.

DETD [0038] A polymer electrolyte **fuel cell** was produced as follows. Platinum was made carried by 5 g of carbon in an amount of 10 wt % . . . resulting electrolyte membrane, an anode-side collector 6 and a cathode-side collector 7 were formed of carbon fiber. The polymer electrolyte **fuel cell** was accommodated in a housing (A)1 and a housing (B)2 which were formed of an acrylic resin which was an . . . were located on the outer sides of the anode 4 and the cathode 5. A mixture liquid, 3 mL, of **formate-hydrogen lyase** and *Clostridium butyricum* cultivated using a liquid medium ATOC38 of a starting pH 8.0 at 30? C. for 10 days was put and. . .

DETD [0039] A polymer electrolyte **fuel cell** is produced in the same manner as Example 1 except that the bacterium and the enzyme were not used for the anode-side collector 6. Further the polymer electrolyte **fuel cell** of Example 2 was provided with a filter 18 connected to the supply inlet 8 for the material for fuel. . . by a connection pipe 17. The filter 18 was formed of the same material as the collectors 6 and 7. *Clostridium butyricum* and **formate-hydrogen lyase** were fixed in part of the filter by the aforesaid method. (see FIG. 2).

DETD [0040] A polymer electrolyte **fuel cell** is produced in the same manner as Example 1 except that the bacterium and the enzyme were not used for. . .

DETD Evaluation Test of polymer electrolyte **fuel cells**

DETD . . . aqueous solution of methanol was fed via the supply inlet 8 for the material for fuel of the polymer electrolyte **fuel cell** of Example 1. When the aqueous solution of methanol passed through the anode-side collector, hydrogen and carbon dioxide gas were generated due to the action of *Clostridium butyricum* and **formate-hydrogen lyase**. Carbon dioxide gas was discharged from the fuel discharge outlet 9 to the outside of the polymer electrolyte **fuel cell** together with excess hydrogen. On the other hand, the generated hydrogen was fed to the anode 4, and was ionized. . . with oxygen ions to produce water on the cathode side. Electrons generated during this reaction are taken out of the **fuel cell** system, whereby electricity was generated constantly for 5 hours.

DETD . . . An aqueous solution methanol was fed via the supply inlet 8 for the material for fuel of the polymer electrolyte **fuel cell** of Reference Example 1. The resulting generation of electricity declined gradually, and stopped after three hours.

DETD [0043] As clearly seen from the examples and reference example, the polymer electrolyte **fuel cell** of the present invention generated electricity more efficiently than the ordinary methanol **fuel cell** which used an oxygen-containing hydrocarbon as fuel but did not use biochemical catalysts. According to the present invention, since carbon. . . the anode, the poisoning of platinum, ruthenium or the like used

for the anode catalyst can be avoided. Further the **fuel cell** can work at low temperatures.

CLM What is claimed is:

1. A polymer electrolyte **fuel cell** comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel; an anode and a cathode. . . .
2. A **fuel cell** according to claim 1 further comprising an anode-side collector and a cathode-side collector which sandwich the anode and the cathode. . . .
3. A polymer electrolyte **fuel cell** comprising: a housing provided with an anode-side supply inlet for supplying a material for fuel, the anode-side supply inlet being. . . .
4. A **fuel cell** according to claim 1 or 3, wherein the biochemical catalyst comprises one or more selected from hydrogen-generative anaerobic bacteria, hydrogen-generative. . . .
5. A **fuel cell** according to claim 1 or 3, wherein the biochemical catalyst comprises a combination of **Clostridium butyricum** and **formate-hydrogen lyase**.
6. A **fuel cell** according to claim 1 or 3, wherein the material for fuel is selected from oxygen-containing hydrocarbons such as alcohols, polysaccharides,. . . .
7. A **fuel cell** according to claim 1 or 3, wherein the material for fuel is in the form of an aqueous solution.

L2 ANSWER (27) OF 28 USPATFULL on STN

Full Text	Citing References
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ACCESSION NUMBER: 2002:154697 USPATFULL  
 TITLE: Integrated anaerobic digester system  
 INVENTOR(S): Ainsworth, Jack L., Canton, TX, UNITED STATES  
 Atwood, Dan, Nassau Bay, TX, UNITED STATES  
 Rideout, Tom, Midland, TX, UNITED STATES

	NUMBER	KIND	DATE
<u>PATENT INFORMATION:</u>	<u>US 2002079266</u>	A1	20020627
	<u>US 6569332</u>	B2	20030527
<u>APPLICATION INFO.:</u>	<u>US 2001-963130</u>	A1	20010924 (9)
<u>RELATED APPLN. INFO.:</u>	Continuation-in-part of Ser. No. <u>US 2000-602684</u> , filed on 26 Jun 2000, PATENTED		
DOCUMENT TYPE:	Utility		
FILE SEGMENT:	APPLICATION		
LEGAL REPRESENTATIVE:	INNOVAR, LLC, P O BOX 250647, PLANO, TX, 75025		
NUMBER OF CLAIMS:	79		
EXEMPLARY CLAIM:	1		
NUMBER OF DRAWINGS:	5 Drawing Page(s)		
LINE COUNT:	1483		

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM . . . engine, a water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, **fuel cell**, or various components of the system itself and/or to recharge power cells; (12) the gas processor comprises a gas scrubber. . . .

DRWD . . . barkeri (methane), Ms. vacuolata (methane), Propionibacterium acidipropionici (methane), Saccharomyces cerevisiae (ethanol), S. ellipsoideus (ethanol), Clostridium propionicum (propanol), Clostridium saccharoacetoperbutylicum (butanol), **Clostridium butyricum** (hydrogen), wherein the chemical in parentheses indicates a useful material which that microbe produces.

CLM    What is claimed is:

- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a fuel cell.
- . . . combustion engine, electrical current generator, electric engine, water heater, furnace, air conditioning unit, ventilation fan, conveyor, pump, heat exchanger, and fuel cell.
- . . . Alcaliphilum, Ms. acetivorans, Ms. thermophilia, Ms. barkeri, Ms. vacuolata, Propionibacterium acidi-propionici, Saccharomyces cerevisae, S. ellipsoideus, Clostridium propionicum, Clostridium saccharoacetoper-butylicum, and Clostridium butyricum.
- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a fuel cell.
- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a fuel cell.
- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a fuel cell.
- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a fuel cell.

L2    ANSWER (28) OF 28    USPATFULL on STN

Full Text	Citing References
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ACCESSION NUMBER:        2001:173040    USPATFULL  
 TITLE:                    Anaerobic digester system  
 INVENTOR(S):             Ainsworth, Jack L., 2419 VZ Cr 2318, Canton, TX, United States 75103  
                               Atwood, Dan, 2746 Lighthouse Dr., Nassau Bay, TX, United States 77058  
                               Rideout, Tom, 4106 S. CR 1185, Midland, TX, United States 79706

	NUMBER	KIND	DATE
PATENT INFORMATION:	US 6299774	B1	20011009
APPLICATION INFO.:	US 2000-602684		20000626 (9)
DOCUMENT TYPE:	Utility		
FILE SEGMENT:	GRANTED		
PRIMARY EXAMINER:	Simmons, David A.		
ASSISTANT EXAMINER:	Prince, Fred		
LEGAL REPRESENTATIVE:	Matos, RickInnovar, L.L.C.		
NUMBER OF CLAIMS:	31		
EXEMPLARY CLAIM:	1		
NUMBER OF DRAWINGS:	4 Drawing Figure(s); 4 Drawing Page(s)		
LINE COUNT:	959		

CAS INDEXING IS AVAILABLE FOR THIS PATENT.

SUMM    . . . operate a water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, fuel cell, or various components of the system itself and/or to recharge power cells; (12) the gas processor comprises a gas scrubber. . .

DETD    . . . barkeri (methane), Ms. vacuolata (methane), Propionibacterium acidi-propionici (methane), Saccharomyces cerevisae (ethanol), S. ellipsoideus (ethanol), Clostridium propionicum (propanol), Clostridium saccharoacetoper-butylicum (butanol), Clostridium butyricum

(hydrogen), wherein the chemical in parentheses indicates a useful material which that microbe produces.

CLM What is claimed is:

- . . . water heater, a furnace, an air conditioning unit, a ventilation fan, a conveyor, a pump, a heat exchanger, and a **fuel cell**.
- . . . combustion engine, electrical current generator, electric engine, water heater, furnace, air conditioning unit, ventilation fan, conveyor, pump, heat exchanger, and **fuel cell**.
- . . . *Alcaliphilum*, *Ms. acetivorans*, *Ms. thermophila*, *Ms. barkeri*, *Ms. vacuolata*, *Propionibacterium acidi-propionici*, *Saccharomyces cerevisiae*, *S. ellipsoideus*, *Clostridium propionicum*, *Clostridium saccharoacetoper-butylicum*, and *Clostridium butyricum*.

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